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A Method for Enhancing Mutual Understanding and Participation

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ABSTRACT: In this article, we introduce a method to make visible the differences among people regarding how they conceptualize the world. The Grounded Intersubjective Concept Analysis (GICA) method first employs a conceptual survey designed to elicit particular ways in which concepts are used among participants, aiming to exclude the level of opinions and values. The subsequent analysis and visualization reveals potential underlying groupings of people, concepts and contexts. An awareness and reflection process is then initiated based on these results. This method, combining qualitative and quantitative components, leads into the externalization and sharing of tacit knowledge. Thereby the GICA method builds up a common ground for mutual understanding, and is particularly well suited for strengthening participatory processes. Participatory methods have been designed for including stakeholders in decision making processes. They do this by eliciting different opinions and values of the stakeholders. The underlying assumption, however, is that there are no significant conceptual differences among the participants. Nevertheless, often the failures of the participatory process can be traced back to such hidden conceptual differences. As an unfortunate outcome, crucial experiential knowledge may go unrecognized or differences in the meanings of words used may be misconstrued as differences in opinions. The GICA method aims at alleviating these problems.

KEYWORDS: Subjectivity, intersubjectivity, communication, miscommunication, participatory methods, data analysis, statistical machine learning

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CONTENTS

1 INTRODUCTION

Often we take for granted that we are able to understand each other. It is the occasional clear failure that allows us to see that understanding language is often difficult.

In making the connection between a word and its typical and appropriate use, we rely on a long learning process. The process is made possible and guided by our genetic make-up, but its success requires also extensive immersion to a culture and contexts of using words and expressions. To the extent that these contexts are shared among individual language speakers we are then able to understand each other. When our learning contexts differ, however, differences in understanding the concepts themselves arise and subsequent communication failures begin to take place.

It is obvious that if the context of learning has been completely different, i.e., if two persons have learned different languages, the basis for mutual understanding through exchanging linguistic expressions is very limited or even non-existent. Self-evidently, without an access to gestures or an external context it is not possible to know what "Ble mae'r swyddfa bost agosaf?" or "Non hurbilen dagoen postetxean da?" means unless one has learned Welsh or Basque language. This example can naturally be extended to less trivial cases as well. Considering the readers of this article it is fair to assume that every one of them speaks English. Nevertheless, it is difficult for most to understand expressions like "a metaphyseal loading implant employes a modified mechanoregulatory algorithm" or "bosonic fields commute and fermionic fields anticommute" unless one is an expert in a particular area of medicine or physics. Even expressions in everyday informal language such as "imma imba, lol" can seem obscure if one is not familiar with the youth language in the internet. In addition to these kinds of clear cut cases there are more subtle situations in which two or several persons think that they understand each other even though they actually do not. It seems realistic to think that a person assumes that others understand her when she says "this is not fair", "do you like me?", "I saw a small house", or "that country is democratic". However, it is far from guaranteed that the others would actually interpret words "fair", "like", "small" or "democratic" in the same way as the speaker.

In this paper, building on previous work (Honkela & Vepsäläinen 1991; Honkela, Könönen, Lindh-Knuutila & Paukkeri, 2008; Janasik, Honkela & Bruun, 2009), we present a methodological innovation that aims to improve a) mutual understanding in communication, and b) the inclusion of stakeholder concerns in complex decision making contexts. The proposed method builds on 1) an understanding of the grounded nature of all concepts, and the dynamic and subjective nature of concept formation and use; and 2) the recognition that the best way to elicit and represent such concepts is one that combines elements from qualitative case research and quantitative learning methods. We call this method Grounded Intersubjective Concept Analysis (GICA). The word 'grounded' refers to both the qualitative method of Grounded Theory (Glaser and Strauss, 1967) and to the idea of the embodied grounding of concepts in human experience (Harnad 1990). The method includes three main steps: (A) Preparation, (B) Focus session(s), and (C) Knowledge to action activities. These steps can be repeated iteratively.

The focus sessions are supported with computational tools that enable the analysis and visualization of similarities and differences in the underlying conceptual systems.

We begin by showing examples of contextuality and subjectivity in interpretation and continue by considering a modern internet-based activity, i.e. crowdsourcing that highlights subjective differences in knowledge-intensive activities.

1.1 Contextuality and subjectivity

It is commonplace in linguistics to define semantics as dealing with prototypical meanings whereas pragmatics would be associated with meanings in context. For our purposes, this distinction is not relevant since interpretation of natural language expressions always takes place in some context, usually even within multiple levels of context including both linguistic and extralinguistic ones. In the contrary case, that is, when an ambiguous word such as “break” appears alone without any specific context one can only try to guess which of its multiple meanings could be in question. If there is even a short contextual cue — “break the law”, or “have a break”, or “how to break in billiards” – it is usually possible to arrive at a more accurate interpretation. Also the extralinguistic context of an expression usually helps in disambiguation.

In some cases, the interpretation of expression can be numerically quantified and thus more easily compared. For instance, the expression “a tall person” can be interpreted as a kind of measure of the height of the person. The interpretation of ’tallness’ can be experimentally studied in two ways. Either one can be asked to tell the prototypical height of a person that is tall, or one can tell whether different persons of some height are tall or not (maybe associated with some quantifiers such as “quite” or “very”). Sometimes this kind of quantification is conducted using the framework of fuzzy set theory (Zadeh 1965). However, consideration of the tallness of a person is only a tip of an iceberg of the complexity of interpretation. A small giraffe or building is usually higher than a tall person. A person who is 5 feet or 1 meter 52 centimeters is not prototypically considered tall – unless a young child is in question. Also many other contextual factors influence the interpretation such as gender, historical time (people used to be shorter hundreds of years ago), and even profession (e.g. basketball players versus fighter pilots).

The tallness example also provides a view on subjectivity. If we ask from a thousand people the question “How tall is a tall person?”, we receive many different answers, and if we ask “If a person is x cm tall, would you call him/her a tall person?”, the answer varies among respondents. The distribution of answers to such questions reflects the individual variation in the interpretation of ‘tall’. If the pattern in question is more complex and a number of context features are taken into account, the issue of subjective models becomes even more apparent, unless it is assumed that such information for interpretation (linking language with perceptions) would be genetically determined. There are some researchers such as Jerry Fodor who suggest that linguistic skills are innate and strongly modular (see, e.g. Fodor 1998). Fodor even claims conceptual contents to be innate and is thus a proponent of extreme concept nativism. However, it seems that the arguments supporting the centrality of learning are more realistic (c.f. e.g. Gärdenfors 2000, Prince & Smolensky 1997, Pulvermüller 2001, Ritter & Kohonen 1989, Smolensky 2006, Tomasello 2000).

Another simple example on subjectivity is found in naming colors. Differences and similarities in color naming and color concepts in different languages have been studied carefully (see e.g. Kay & McDaniel 1978, Cook, Kay & Regier 2005). In addition, unless prototypical colors such as pure black, white, red, green, etc. are chosen, individual people tend to name a sample color in different ways. What is dark blue for someone, may be black to someone else, etc. A similar straightforward illustration of subjectivity of interpretation is the naming of patterns. For instance, people name the shapes shown in Fig. 1 in different ways except for the clear cases in the ends of the continuum (Honkela and Pöllä 2009). It is important to note that the

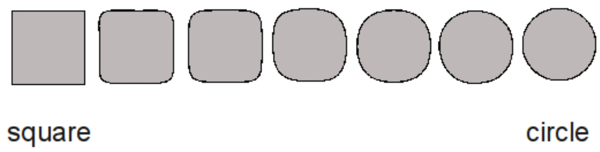

Figure 1: A continuum of shapes.

kind of subjectivity discussed above is usually not dealt with in computational or formal theories of language and understanding. On the other hand, this phenomenon is self-evident for practitioners in many areas of activity as well as in relation to practice oriented fields in the humanities. However, subjectivity has been difficult to quantify. In this paper, we introduce a method that is meant to make the subjectivity of interpretation and understanding explicit and visible even in non-trivial cases.

1.2 Shedding light on subjectivity: crowdsourcing

In the Web 2.0 world, crowdsourcing is a specific activity that relies on the input from masses of people (see e.g. Brabham 2008). In crowdsourcing, tasks traditionally performed by an employee or contractor are outsourced to a group people or community in the form of an open call. Social bookmarking is a specific example of crowdsourcing in which the expert task of meta data provision as library categories or keywords is replaced by an activity by masses of users. They label items such as articles or books to characterize their contents. In contrast with the expert activity, in social bookmarking no formalized category system or keyword list is in use. This means, in practice, that the individual variation in labeling becomes clearly visible. For example, in the social bookmarking web site delicious.com the Wikipedia page on the Self-Organizing Map (SOM) method has been given one to twelve labels by 128 different users (as of 20th of October, 2009). The labels for SOM given by at least 10 users are: AI, neural networks, visualization, som, wikipedia, clustering, programming, neural, kohonen, research, network, algorithms, and statistics. Additionally, a large number of labels was suggested by one or two users only. Examples of such rare labels include neurotic, mind map, and research result. This illustrates the idea that there is a shared prototypical core with large amount of variation surrounding it. It seems, however, that the most common labels coincide with the ones that an expert would give. This is partly explained by the fact that many of the users are either experts, students as emerging experts, or professional amateurs. Moreover, the subjectivity in labeling is not limited to social bookmarking. Furnas et al. (1987) have found that in spontaneous word choice for objects in five domains, two people favored the same term with a probability that was less than 0.2. Similarly for indexing documents with words, where Bates (1986) has shown that different indexers, who are well trained in the indexing scheme, might assign index terms for a given document differently. It has also been observed that an indexer might use different terms for the same document at different times. These kinds of differences can partly be explained by randomness in the word choice but an essential component also seems to be the differences in how people conceptualize various phenomena. In the following, we introduce with increasing detail how these differences can be made visible.

1.3 Becoming conscious of individual differences as a way of increasing understanding

For the most part, people do not seem to be aware of the subjectivity of their perceptions, concepts, or world views. Furthermore, one might claim that we are more typically conscious of differences in opinions, whereas differences in perception or in conceptual level are less well understood. It is even possible that to be able to function efficiently it is best to mostly assume that my tools of communication are shared by people around me. However, there are situations where this assumption breaks to a degree that merits further attention. An example is the case when speakers of the same language from several disciplines, interest groups, or several otherwise closely knit cultural contexts come together to deliberate on some shared issues.

The background assumption of the GICA method innovation is the recognition that although different people may use the same word for some phenomenon, this does not necessarily mean that the conceptualization underlying this word usage is the same; in fact, the sameness at the level of names may hide significant differences at the level of concepts. Furthermore, there may be differences at many levels: experiences, values, understanding of the causal relationships, opinions and regarding the meanings of words. The differences in meanings of words are the most deceptive, because to discuss any of the other differences, a shared vocabulary which is understood in roughly the same way, is necessary. Often a difference in the meanings of used words remains unrecognized for a long time; it may, for instance, be misconstrued as a difference in opinions. Alternatively, a difference in opinions, or regarding a decision that the group makes, may be masked and remain unrecognized, because the same words are used seemingly in accord, but in fact in different meanings by different people. When these differences are not recognized during communication, it often leads to discord and unhappiness about the end result. As a result, the joint process may be considered to have failed in one or even all of its objectives.

Mustajoki (2008) present a model of miscommunication for which the underlying insights and motivation resembles to a large extend this article as well as the model presented in (Honkela et al. 2008). He concludes that in the scientific literature on failures in communication different terms are occasionally used to describe similar matters and researchers also tend to use the same terms with different meanings. In this article, we do not aim to review the research on miscommunication but refer to (Mustajoki 2008) as a good overview. In the following, we present as our contribution a division into two main types of problems.

1.4 False agreements and false disagreements

Undiscovered meaning differences can cause two types of problems. The first type is *false agreement*, where on the surface it looks as if we agree, but in fact our conceptual difference hides the underlying difference in opinions or world views. For example, we might all agree that "the Aalto University should be innovative" or that "Aalto University should aim at excellence in research and education" but could totally disagree about what "innovative" or "excellence" means. As another example, we might agree that "we need a taxing system that is fair and encourages people to work" but might be in considerable disagreement regarding the practical interpretation of "fair" and "encourages".

The second type of problem caused by undiscovered meaning differences is *false disagreement*. If we are raised (linguistically speaking) in different sub-cultures, we might come to share ideas and views, but might have learned to use different expressions to describe them. This may lead to considerable amount of unnecessary argument and tension, in short, surface disagreement, that hides the underlying agreement.

Since a lot of human endeavour when meeting with others seems to deal with uncovering conceptual differences in one way or another, it would be beneficial to have tools which can aid us in the discovery process—tools which might make visible the deeper conceptual level behind our surface level of words and expressions.

1.5 Making differences in understanding visible

Our aim with the Grounded Intersubjective Concept Analysis (GICA) method is to devise a way in which differences in conceptualization such as described above can be made visible and integrated into complex communication and decision making processes. An attempt to describe the meaning of one word by relying on other words often fails, because the descriptive words themselves are understood differently across the domains. In fact, a domain may have a large number of words that have their specialized meanings. The more specific aims of this paper are to define the problem domain, to explain the processes of concept formation from a cognitive point of view based on our modeling standpoint, and to propose a methodology that can be used for making differences in conceptual models visible in a way that forms a basis for mutual understanding when different heterogeneous groups interact. Contexts of application are, for instance, public planning processes, environmental problem solving, interdisciplinary research projects, product development processes, and mergers of organizations.

Our view is that the GICA method, by allowing the elicitation, representation and integration of concepts grounded in the experience of stakeholders, takes participatory methods one step further. Last but not least, by allowing the integration of conceptual and experiential worlds of lay stakeholders usually deemed marginal from the point of view of existing modes of producing expertise (such as, e.g., science and engineers), it can be seen as a providing a tool for reducing marginalization.

In the following, we will discuss the theoretical background of the GICA method, and present the method in detail. If the reader is mainly interested in the practical value and application of the method, the following section may be skipped.

2 THEORETICAL BACKGROUND

The section on the cognitive theory of concepts focuses on how subjectivity in understanding can be explicitly modeled in a way that provides a basis for the quantitative analysis presented in Chapter 3.

2.1 Cognitive theory of concepts and understanding

The amount of philosophical and scientific literature on concepts is huge and it is not possible to review here any significant proportion of it.

According to one common view, often held by logic-oriented researchers, concepts are seen independent of any historical, contextual or subjective factors. The works in the tradition of analytical philosophy typically represent this kind of view. One attempt to create a connection between linguistic expressions and formal concepts was Richard Montague's work (Montague 1973). His central thesis was that there is no essential difference between the semantics of natural languages (like English) and formal languages (like predicate logic), i.e., there is a rigorous way how to translate English sentences into an artificial logical language (Montague 1973). Montague grammar is an attempt to link directly the syntactic and semantic level of language. In order to do so, Montague defined the syntax of declarative sentences as tree structures and created an interpretation of those structures using an intensional logic. The end result was a focus on such aspects of language that nicely fit with the theoretical framework. Examples of language considered includes sentences like "Bill walks", "every man walks", "the man walks", and "John finds an unicorn" (Montague 1973). It may be fair to say that most of the linguistic phenomena are set aside. Montague even assumes that the original sentences can be considered unambiguous even though ambiguity is a central phenomenon in language at many levels of abstraction. The idea of being rigorous may be considered a proper stand but it often leads to the negligence of the original complexity of the phenomenon being considered (Von Foerster 2003).

Many philosophers outside the analytical tradition have already for some time criticized the approach of logical formalization within philosophy of language. For instance, representatives of phenomenology (e.g. Edmund Husserl and Martin Heidegger), hermeneutics (e.g. Martin Heidegger and Hans-Georg Gadamer) and critical theory (e.g. Max Horkheimer and Jürgen Habermas) have presented alternative views. Richard Rorty (1979) attacks the correspondence theory of truth (that truth is established by directly comparing what a sentence asserts regarding the "facts" applying), and even denies that there are any ultimate foundations for knowledge at all. He calls for a socially-based theory of understanding. He also strongly criticizes the notion of truth: Truth is not a common property of true statements, and the good is what proves itself to be so in practice. Rorty combines pragmatism (cf. e.g. John Dewey and Charles S. Peirce) with the philosophy of language by later Wittgenstein which declares that meaning is a social-linguistic product. It is far from obvious that communication between speakers of one and the same language would be based on commonly shared meanings as often suggested by the proponents of formal semantics, either explicitly or implicitly. This leads to the rejection of the idea of an idealized language user and to the rejection of the possibility of considering central epistemological questions and natural language semantics without consideration of subjectivity and variability. In other words, the language of a person is idiosyncratic and based on the subjective experiences of the individual (Honkela, 2007). Carey (2009) considers carefully the relationship between cognition and concepts and provides a useful developmental view.

At the socio-cultural level, humans create and share conceptual artifacts such as symbols, words and texts. These are used as mediators between different minds. In communicating and sharing knowledge, individuals have to make a transformation between their internal representation into an explicit representation to be communicated – and vice versa. The internalization and externalization processes take place as a continuous activity. In externalization, the internal view is externalized as explicit and shared representations. In the internalization process, an individual takes an expression and makes it her own, perhaps using it in a way unique to herself (cf. e.g. Santrock 2004). The internalization of linguistic signs typically takes place as an iterative process. An individual is exposed to the use of an expression in multiple contexts. This distribution of contexts provides a view on the meaning of the expression as it is commonly understood by the others. However, due to differences in the individual life and learning paths, different subjects have gained different conceptual constructions. Therefore, the language use includes subcultures as well as individual idiosyncrasies. The idea of different points of view is illustrated in Fig. 2.

One classical, but in this context less useful, approach for defining concepts is based on the idea that a concept can be characterized by a set of defining attributes. As an alternative, the prototype theory of concepts proposes that concepts have a prototype structure and there is no delimiting set of necessary and sufficient conditions for determining category membership—instead, the membership can be graded. In prototype theory, instances of a concept can be ranked in terms of their typicality. Membership in a category is determined by the similarity of an object's attributes to the category prototype. The development of prototype theory is based on the works by, e.g., Rosch (1973) and Lakoff (1987).

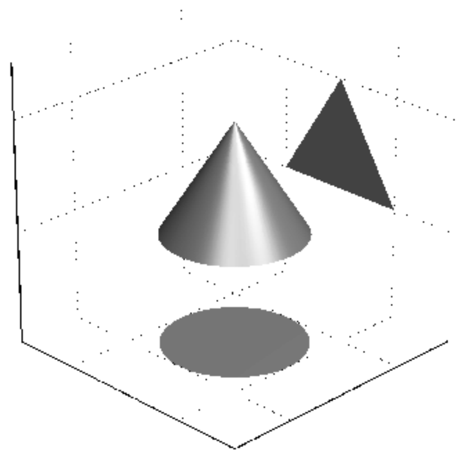

Figure 2: Illustration of the effect of the point of view. The cone can be seen as a triangle or as a circle depending on the dimensions of reality that are observed or factors that are valued.

Gärdenfors (2000) distinguishes between three cognitive levels of representation. The most abstract level is the symbolic level, at which the information is represented in terms of symbols that can be manipulated without taking into account their meaning. The least abstract level is the subconceptual representation. Concepts are explicitly modeled at the mediating level of the conceptual representation.

A conceptual space is built upon geometrical structures based on a number of quality dimensions (Gärdenfors 2000). Concepts are not independent of each other but can be structured into domains, e.g., concepts for colors in one domain, spatial concepts in another domain. Fig. 3 shows an example of a conceptual space consisting of two quality dimensions, and two different ways (A and B) of dividing the space into concepts.

In general, the theory of conceptual spaces proposes a medium to get from the continuous space of sensory information to a higher conceptual level, where concepts could be associated with discrete symbols. This mapping is a dynamic process. Gärdenfors (2000) has proposed that for example multi-dimensional scaling (MDS) and self-organizing maps (SOM) (Kohonen, 2001) can be used in modeling this mapping process. The simplest connection between the SOM and conceptual spaces is to consider each prototype or model vector m in a SOM as an emerged conceptual category c. Related research on conceptual modeling using the SOM includes (Ritter & Kohonen 1989, Honkela, Pulkki & Kohonen 1995, Lagus, Airola & Creutz, 2002, Raitio et al., 2004).

2.2 Subjective conceptual spaces

Two persons may have very different conceptual densities with respect to a particular topic. For instance, in Fig. 3 person A has a rather evenly distributed conceptual division of the space, whereas person B has a more fine-grained conceptual division on the left side of the conceptual space, but has lower precision on the right side of the space.

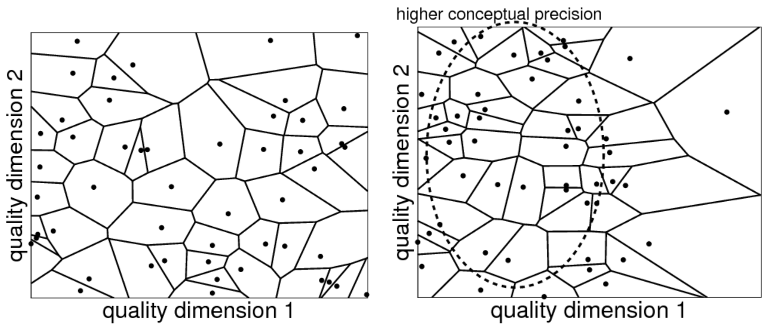

Figure 3: Illustration of differing conceptual densities of two agents having a 2-dimensional quality domain. Points mark the locations of the prototypes of concepts. Lines divide the concepts according to Voronoi tessellation. Both agents can discriminate an equal number of concepts, but abilities of the agent B are more focused on the left half of the quality dimension 1, whereas agent A represents the whole space with rather equal precision.

When language games were included in the simulation model, it resulted in a simple language emerging in a population of communicating autonomous agents (Lindh-Knuutila, Lagus & Honkela 2006). In the population, each agent first learned a conceptual model of the world, in solitary interaction with perceptual data from the world. As a result, each agent obtained a somewhat different conceptual representation (a schematic illustration of the kinds of differences that can arise is shown in Fig. 3). Later, common names for the previously learned concepts were learned in communication with another agent.

2.3 Intersubjectivity in conceptual spaces

If some agents speak the "same language", many of the symbols and the associated concepts in their vocabularies are the same. A subjective conceptual space emerges through an individual self-organization process. The input for the agents consists of perceptions of the environment, and expressions communicated by other agents. The subjectivity of the conceptual space of an individual is a matter of degree. The conceptual spaces of two individual agents may be more or less different. The convergence of conceptual spaces stems from two sources: similarities between the individual experiences (as direct perceptions of the environment) and communication situations (mutual communication or exposure to the same linguistic/cultural influences such as upbringing and education, and artifacts such as newspapers, books, etc.). In a similar manner, the divergence among conceptual spaces of agents is caused by differences in the personal experiences/perceptions and differences in the exposure to linguistic/cultural influences and artifacts.

The basic approach regarding how autonomous agents could learn to communicate and form an internal model of the environment applying the self-organizing map algorithm was introduced, in a simple form, in (Honkela 1993). The model has been later substantially refined in (Lindh-Knuutila, Honkela & Lagus 2006, Honkela et al. 2008).

2.4 Conceptual differences in collaborative problem solving

Collaborative problem solving among experts can in principle be achieved in two ways: (1) by bringing forth a combination of the opinions of the experts by e.g. voting, or (2) by a more involved sharing or integration of expertise and experience at the conceptual level. A particular form of sharing expertise is sharing prototypes. This refers to a process in which an expert communicates prototypical cases to the other expert. So-called boundary objects (Star & Griesemer 1989), i.e. objects or facts that are well-known across various backgrounds and scientific disciplines, are often used as suitable prototypical cases. In the methodological context of the self-organizing map and other prototype-based conceptual models, this means transmitting a collection of model vectors m_i.

Let us consider the features (essentially quality dimensions; Gärdenfors 2000) that span the conceptual space, data set ("experience") used by an individual expert in learning the structure of its conceptual space, and the naming of concepts. These three elements give rise to a typology of conceptual differences among experts. In the following, we present these different categories as well as the basic approaches for dealing with problems related to each category.

a) In the simplest case, the quality dimension space and data set are (nearly) equivalent for both agents. Only concept naming differs among different agents. An agent has an individual mapping function that maps each symbol to the conceptual space of the agent. In a classical simulation of this kind, a number of robots with cameras learned to name visual objects in a similar manner (see Steels 1998). An active research in language games and language evolution has since emerged (see e.g. Vogt 2005, Lindh-Knuutila, Honkela & Lagus 2006, Honkela et al. 2008). Chen (1994) has presented a specific solution to the vocabulary problem among humans based on clustering. Irwin's (1995) view that contextual knowledge may ultimately be constructed in scientific terms might be rooted in the view that differences in perspective are mainly a matter of concept naming. This view might also figure in the background of much traditional or "standard" thinking in the domains of medicine and innovation.

b) As a step towards increased differences among the agents, one may consider the situation in which the feature space is equivalent, but data set per expert varies. One expert has denser data from one part of the concept space, the other for another part (see Fig. 3). An obvious approach for efficient decision making is to use the expertise of those agents whose conceptual mapping is densest with regard to the problem at hand. However, in many cases, problem solving requires combination of many elements e.g. as solutions of subproblems. In those cases, each element can be dealt with by the expert with the densest conceptual mapping regarding a particular subproblem. Collins and Evans' (2002) advocation of the extension of "technical" expertise to include also "uncertified", experience-based expertise might be rooted in the view that there exists a multitude of dense data sets, some of which are officially credentialized while others are not. This view might also be behind calls for taking the views and experiences of patients more seriously, as well as behind recent calls to integrate the perspective of the user in the innovation process at an earlier stage than is often the case (e.g. Hyysalo 2006).

c) Finally, consider the most challenging case where neither the quality dimension space nor the data set are the same for both agents. Fig. 2 depicts a simple case in which the quality dimension spaces are different, therefore offering different viewpoints of the same "data sample" to the agents. In this case, a process of data augmenting can take place: if a subset of data samples known to both can be found (for example, boundary objects known across disciplines, or in terms of medicine, a particular patient's case), each agent can bring forth their particular knowledge (i.e. values of quality dimensions known only to them) regarding that case. Furthermore, in addition to collaborating in solving the present problem, both agents also have the opportunity to learn from each other: to augment their own representation with the new data offered by the other expert. Obtaining augmented information regarding several data samples will lead to the emergence of new, albeit rudimentary quality dimensions, and allow easier communication in future encounters. As an example, mutual data augmentation can take place between doctors of different specialization, doctors and patients, or between doctors and nurses, who consider simultaneously the same patient case. In optimal circumstances, this may eventually lead to better expertise of both. However, this requires that the doctor also trusts the patient, and is willing to learn and store the experiential data communicated by the patient. Essentially the same preconditions for and constraints to the process of data augmenting apply in the contexts of environmental policy and innovation.

3 THE GICA METHOD

In the following, we present a method called Grounded Intersubjective Concept Analysis (GICA) for improving the visibility of different underlying conceptual systems among stakeholder groups.

The method includes three main stages:

A Preparation,

B Focus session(s), and

C Knowledge to action activities.

These steps can be repeated iteratively. The focus sessions are supported with computational tools that enable the analysis and visualization of similarities and differences in the underlying conceptual systems. In this presentation, we use the Self-Organizing Map algorithm (Kohonen 1982, 2001)—however, also other methods for dimensionality reduction and visualization could be used including multidimensional scaling (MDS) (Kruskal & Wish 1978, see also Venna & Kaski 2006), Curvilinear Component Analysis (CCA) (Demartines & Hérault 1997), Isomap (Tenenbaum, de Silva & Langford 2000), or Neighbor Retrieval Visualizer (NeRV) (Venna et al. 2010). Hierarchical clustering or decision tree learning methods are not recommended for the current purpose because they may create artifactual categorical distinctions which actually do not exist. In fact, one of the underlying motivations for the proposed method is to help people to realize that real world phenomena have a lot of underlying complexity which is not visible if conceptual categorizations are applied too straightforwardly.

Figure 4: Aalto University students participating EIT ICT Labs activity “Wellbeing Innovation Camp”.

In this report, the GICA method is illustrated with a case study related to wellbeing concepts. The topic was handled in the EIT ICT Labs activity “Wellbeing Innovation Camp” that took place from 26th to 29th of October 2010 in Vierumäki, Finland. The seminar participants, mainly from Aalto University School of Science and Technology, Macadamia Master’s Programme in Machine Learning and Data Mining and from Aalto University School of Art and Design, Department of Design (see Fig. 4.

3.1 Introduction to subjectivity and context analysis

A word does not carry any information in its form about its meaning. The surface form of the word “cat’ is close to the word “mat”, but its meaning can be deemed to be closer to “dog” than to “mat”. It is possible, though, to study the relationships of words based on the context in which they appear. Let us consider an illustrative example shown in Fig. 5. On the left most column are the words under consideration. There are eight columns each indicating a document. The cells in the table contain frequencies of how often a word appears in a document. In this simple example, it is clear already through visual inspection that the words “house”, “building”, “bridge” and “tower” appear frequently in document numbered from 1 to 4, whereas the words “cat”, “dog”, “horse” and “cow” can be found often in documents numbered from 5 to 8.

The self-organizing map (SOM) (Kohonen 2001) serves several analysis functions. First, it provides a mapping from a high-dimensional space into a low-dimensional space, thus providing a suitable means for visualization of complex data. Second, the SOM reveals topological structures of the data. Two points close to each other on the map display are near each other also in the original space (however, the long map distances do not always correspond with long distances in the original space). The SOM has been used extensively for analyzing numerical data in a number of areas, including various branches of industry, medicine, and economics (Kohonen 2001). The earliest case of using the SOM to analyze contexts of words was presented in (Ritter & Kohonen 1989).

The illustrative simple data shown in Fig. 5 can be analyzed using the

Word	Document number							
	1	2	3	4	5	6	7	8
cat	0	1	0	0	7	4	9	7
dog	1	0	0	2	6	3	7	5
horse	0	0	1	0	2	8	5	3
cow	1	1	0	0	4	6	8	2
house	8	3	2	9	0	0	1	1
building	7	1	1	7	0	1	0	0
bridge	3	7	5	1	0	0	0	0
tower	2	9	8	0	0	0	1	0

Figure 5: An illustrative example of a data set where the number of occurrences of the words in eight different documents is given.

SOM, resulting in a map shown in Fig. 6. Relative distances in the original eight-dimensional space are illustrated by the shading: the darker an area on the map, the higher the distance. Therefore, it is clearly visible, for instance, that the words "tower", "bridge", "house" and "building" are separated from the words "horse", "cow", "cat", and "dog". When richer contextual data is available, more fine-grained distinctions emerge (see, e.g., Honkela, Pulkki & Kohonen 1995, Lagus, Airola & Creutz 2002).

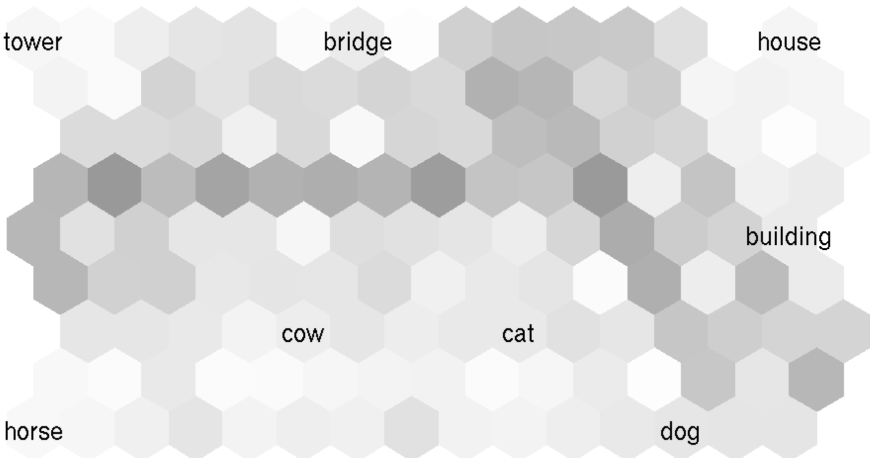

Figure 6: A map of words as a results of a SOM-based analysis of a term-document matrix.

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In the GICA method, the idea of considering the statistics of some items such as words in their contexts is taken a step further. As we have in the introductory section of this paper aimed to carefully show, subjectivity is an inherent aspect of interpretation. In order to capture the aspect of subjectiveness, we add a third dimension to the analysis. Namely, we extend the equation $items \times contexts$ into $items \times contexts \times subjects$, i.e. we consider what is the contribution of each subject in the context analysis. This idea is illustrated in Fig. 7.

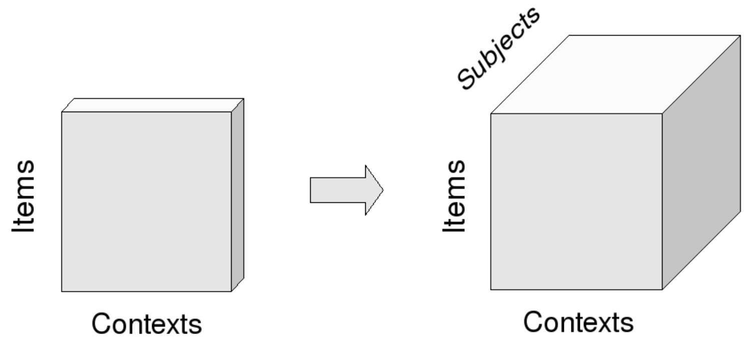


Figure 7: An illustration of an item-context matrix of rank two expanded into a "subjectivity cube" of rank three. In other words, we perform an extension of a $a \times c$-dimensional matrix into a $a \times c \times s$-dimensional data matrix in which the data provided by different subjects on focus items and contexts are included. Here a refers to the number of items, c to the number of contexts, and s to the number of subjects.

For the practical analysis of the data, it is useful to flatten the cube in one way or another to obtain an analysis of the focus items, subjects and contexts. Such flattening is shown in Figs 8 and 9.

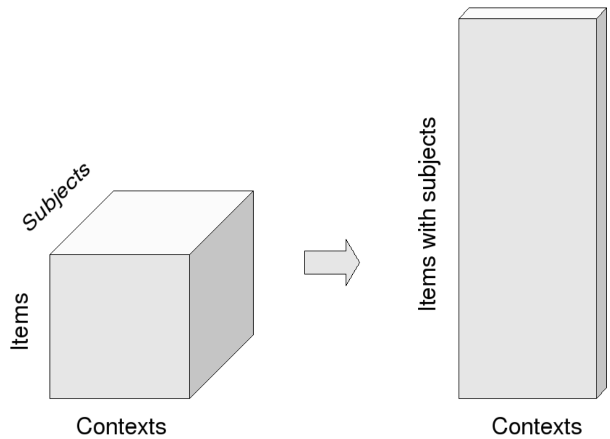


Figure 8: The $a \times c \times s$-dimensional subjectivity cube flattened into a matrix in which each row corresponds to a unique combination of a subject and an item and each column corresponds to a particular context. The number of rows in this matrix is $a \times s$ and the number of columns is c. A specific analysis of such a matrix on wellbeing concepts is shown in Fig. 14. If this matrix is transposed, i.e. columns are transformed into rows and vice versa, an analysis of the contexts can be obtained. This is demonstrated in Fig. 16.

3.2 Preparation and specifying the topic

The purpose of the preparatory step is to collect necessary information for a workshop or series of workshops that are called focus sessions. The preparation is typically organized by a person or group to whom the topic is im-

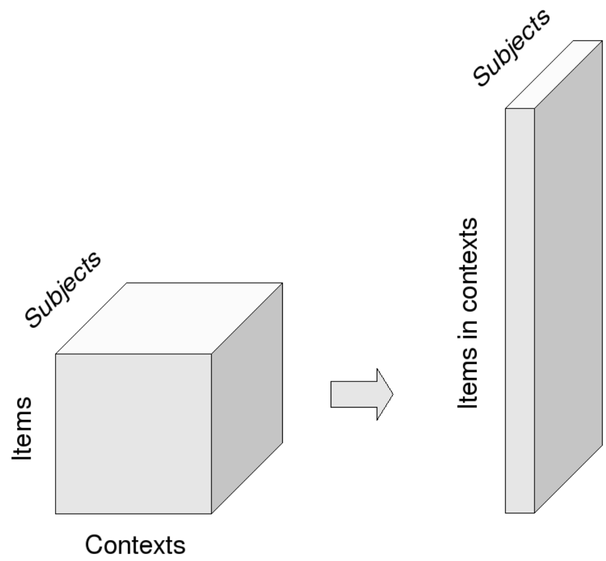


Figure 9: The $a \times c \times s$-dimensional subjectivity cube flattened into a matrix in which each column corresponds to a subject and each row to a unique combination of an item and a context. The number of rows in this matrix is $a \times c$ and the number of columns is s. A transpose of this matrix gives rise to a map of persons (see Figure 17).

portant but who preferably does not have a strong bias related to the topic and thus is able to respect the importance of multiple points of view. In the preparation, the topic at hand and relevant stakeholder groups need to be specified. The representatives of stakeholder groups help in collecting information needed in the focus session stage (B). The detailed steps of the preparation are described below.

The topic needs to be described in some detail to set a context for the process. The topic may be anything ranging from issues such as nuclear power to others like preventive health care. In our illustrative case the topic is wellbeing. A related, but not a full GICA analysis of subjective conceptions have been conducted in the area of philosophical education (Rusanen, Lappi, Honkela & Nederström 2008) and religious belief systems (Pyysiäinen, Lindeman & Honkela 2003).

Determining relevant stakeholder groups

When the topic has been fixed, it is important to determine the relevant stakeholder groups and invite representatives of those into the process. For the success of the process, it is beneficial to invite people with very different backgrounds concerning their education and experience related to the topic at hand. Inside a company, this might mean inviting representatives from marketing and sales as well as product development departments. In our case, we had two student groups, one consisting of students of information and computer science (machine learning and data mining in particular) and the other one design students. In a full scale application of the GICA method, wellbeing concepts could be considered by stakeholders representing citizens/consumers, patients groups, healthcare professionals, administrators and politicians.

Collecting focus items from relevant stakeholders and others

The focus items should represent central conceptual themes related to the topic at hand. These items are usually terms that are used in the domain, with the assumption that they are known by all the participants without further explanation. They may be terms regarding which we suspect that there might exist conceptual differences among the participants, or terms on which having a shared understanding is of central importance. In any case, the focus items should be chosen so that the possibility for revealing the most important conceptual differences is maximized.

In our illustrative example, the items are chosen from the domain of wellbeing. Originally the list consisted of eight items (wellbeing, fitness, tiredness, good food, stress, relaxation, loneliness and happiness), but at a later stage of the process the list was narrowed down to four items (relaxation, happiness, fitness, wellbeing).

Collecting context items

The next step in the method is to collect a number of relevant contexts towards which the previously collected focus items can be reflected. In principle, the context items can be short textual descriptions, longer stories, or even multimodal items such as physical objects, images or videos. The underlying idea is that between the focus items and the contexts there is some kind of potential link of a varying degree. It is important to choose the contexts in such a manner that they are as clear and unambiguous as possible. The differences in the interpretations of the focus items is best revealed if the "reflection surface" of the context items is as shared as possible among the participants. Therefore, the context items can include richer descriptions and even multimodal grounding.

The number of focus items and contexts determines the overall number of inputs to be given. Naturally, if the number of focus items and/or contexts is very high, the task becomes overwhelming to the participants. Therefore the number of focus items should be kept reasonable, for instance between 10 and 15, and the number of contexts should be such that the dimensions are enough to bring to the light the differences between the conceptual views of the persons.

In other terms, there is an important link to the theoretical aspects introduced in Chapter 2. Namely, focus items are positioned to the space spanned by the dimensions of the contextual items.

In the wellbeing workshop, the participants were asked to list concepts related to eight areas related to wellbeing (wellbeing, fitness, tiredness, good food, stress, relaxation, loneliness and happiness). The participants listed 744 terms among which 182 were mentioned by more than one person. Unique items included "homesickness", "handicrafts", "grandma's pancakes", etc. The terms that appeared more than 5 times are shown in Fig. 10. From the set of these 37 terms 24 were finally selected as the context items (see Fig. 11).

Item	Frequency	Item	Frequency
friends	33	safety	7
health	23	exercise	7
family	23	delicious	7
sleep	14	success	6
music	13	sleeping	6
work	11	relaxation	6
time	10	pressure	6
happiness	10	nutrition	6
depression	10	nature	6
stress	9	home	6
sports	9	wine	5
healthy	9	satisfaction	5
fresh	9	physical health	5
food	9	love	5
darkness	9	hurry	5
sport	8	healthy food	5
freedom	8	deadline	5
travelling	7	bed	5
social interaction	7	...	...

Figure 10: Most common items associated by the participants with eight terms related to wellbeing.

3.3 Focus session

The topic, focus items and contexts are presented by the session organizer to the participants. The presentation should be conducted as "neutrally" as possible to avoid raising issues that refer to the value or opinion differences related to the topic. Naturally, such connotations cannot be fully avoided and therefore some means for creating a generally relaxed and respectful atmosphere should be in use. The presentation of the focus items should be very plain so that no discussion is conducted related to them, i.e. basically they are just listed. On the other hand, the contexts are introduced with some detail. They are meant to be the common ground. Referring to the theory

Time	Family	Freedom
Travelling	Health	Enjoyment
Sport	Sleep	Success
Exercise	Music	Nutrition
Work	Pleasure	Sun
Friends	Satisfaction	Nature
Social interaction	Relaxation	Forest
Sharing	Harmony	Money

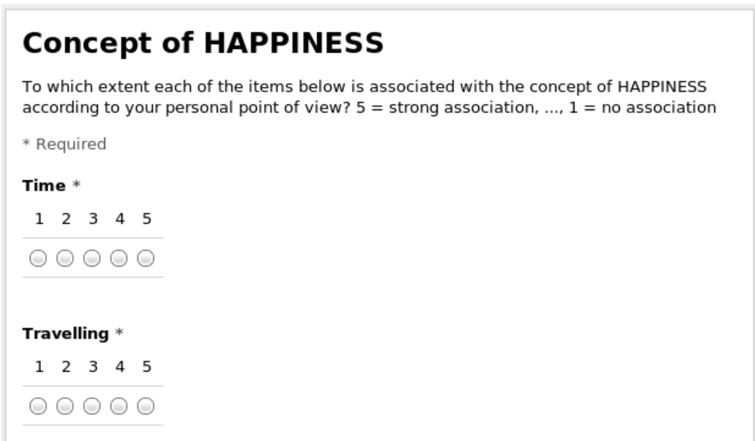
Figure 11: Context items for the wellbeing case, selected from the most common terms generated by workshop participants by association.

of concepts (see Section 2), the context items serve as the quality dimensions that span the conceptual space. In order to effectively compare the differing conceptions related to the focus items, it is thus important that the grounding dimensions are understood as commonly as possible. This is, of course, only possible to some degree.

As a result of this step, the participants are aware of the context items which are used in the analysis and should be ready to fill in a questionnaire that is presented to them in the next step.

Filling in the Cube

The participants are then asked to fill in a data matrix which typically consists of the focus items as rows and the contexts as columns. Each individual's task is to determine how strongly a focus item is associated with a context. A graded scale can be considered beneficial.



Concept of HAPPINESS

To which extent each of the items below is associated with the concept of HAPPINESS according to your personal point of view? 5 = strong association, ..., 1 = no association

* Required

Time *

1 2 3 4 5

Travelling *

1 2 3 4 5

Figure 12: A fraction of an input form implemented using Google Docs.

There are several options regarding how the data collection can be conducted. It is possible to create a form on paper that is given to the participants to be filled in (such as in Fig. 12). Filling in the data takes place usually during the session because it is preceded by the introduction to the contexts. If there are any open questions related to the contexts, these are answered and discussed in a shared manner so that potential for creating a shared ground is maximized.

The data can also be collected with the help of some technological means. For instance, the participants may have access to a web page containing the input form, or the same functionality can be provided with mobile phone technology. In our wellbeing case, we used Google Docs to implement the questionnaire (see Fig. 12). This kind of web-based solution makes it easier to continue with the analysis as the data is readily in electronic form.

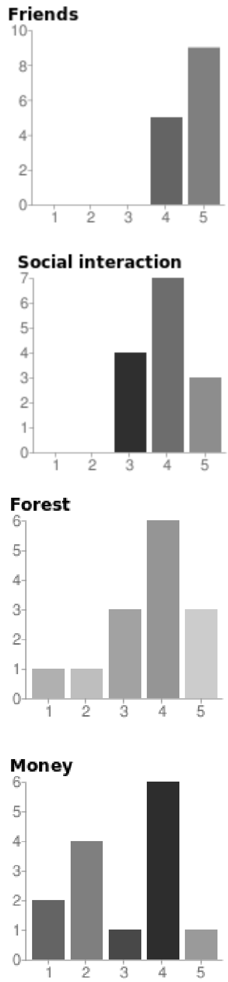
For further processing, the input data must be encoded as a data matrix that consists of all the answers by the participants. There are several possibilities for this. For instance, if the data has been gathered in paper form, there must be enough human resources available for typing these into the computer system. A simple solution is to have a spreadsheet file. In it, from each participant we now have a "data sheet" of the kind depicted in Fig. 4.

Together these sheets form the data cube.

As a result of this step, the "Cube" is full of data ready for analysis. In our example, the size of the data cube is 4 x 24 x 13 (concepts, context items, subjects), and each point in the cube is a number between 1–5. The data analysis process is presented in the following.

Data analysis and visualization

The data collected in the previous task is analyzed using some suitable data analysis method. The essential aspect is to be able to present the rich data in a compact and understandable manner so that the conceptual differences are highlighted. In the following, we present an example where we look at some details of the data cube using histograms, and then try to form an overview using the Self-Organizing Map algorithm. As discussed earlier, other similar methods can also be applied.



1	**0**	0%
2	**0**	0%
3	**0**	0%
4	**5**	36%
5	**9**	64%

1	**0**	0%
2	**0**	0%
3	**4**	29%
4	**7**	50%
5	**3**	21%

1	**1**	7%
2	**1**	7%
3	**3**	21%
4	**6**	43%
5	**3**	21%

1	**2**	14%
2	**4**	29%
3	**1**	7%
4	**6**	43%
5	**1**	7%

Figure 13: The distribution of answers for some context items associated with happiness. Among these four contexts, friends seem to be most positively associated with happiness, followed by social interaction. At least in this rather small data set, money has an interesting bimodal distribution with two peaks.

The diagrams in Fig. 13 represent a small fraction of the data gathered in our wellbeing case. Looking at these can be very informative for deeper analysis of individual concepts in terms of their context items. For example, here we can conclude that the strong connection between Friends and Happiness is generally agreed, whereas the connection between Money and Happiness shows considerable variation, with Social interaction and Forest falling in between.

Next, we will look at ways to summarize the data cube more holistically from different angles.

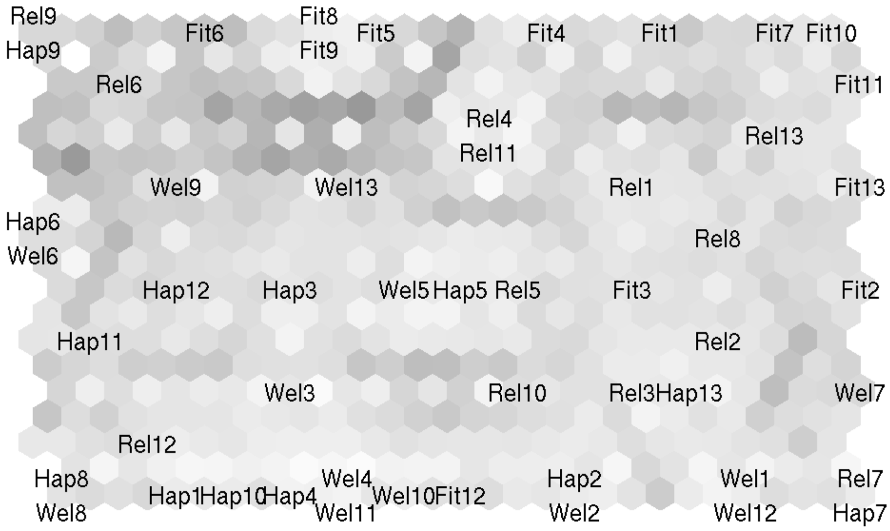


Figure 14: Map of the subjects (numbered 1-13) and their views on wellbeing (Wel), happiness (Hap), fitness (Fit) and relaxation (Rel).

When the subject-focus item-context cube is available, there are several options for analyzing it. The basic option is to consider all alternatives presented in Figs 8 and 9. These alternatives include creating a map of 1) the subjects and focus items jointly based on the context items (see Fig. 14), 2) the context items based on how they were associated with the focus items by each of the subjects (see Fig. 16), and 3) the subjects based on their responses considering the relationship between the focus and context items (see Fig. 17).

In our case, the subjects cannot be identified, neither they are divided into any classes. In an analysis supporting some participatory process, the subjects could be labeled on the map with the stakeholder information. This would facilitate insights on differences of the conceptual views held by different stakeholder groups.

In the present analysis on the wellbeing concepts, one clear finding can be reported. Namely, after a careful inspection Fig. 14 reveals that the views on relaxation are widely scattered on the map whereas especially the concepts of happiness and fitness are much more concentrated on the map and therefore intersubjectively shared. Happiness becomes located on the left and lower parts of the map. Fitness is located on the upper and upper right parts. As a strikingly different case, relaxation is not viewed in an uniform manner by the subjects. For example, for the subject 9, relaxation is located on the upper left corner of the map whereas the subject 7 is located on the opposite

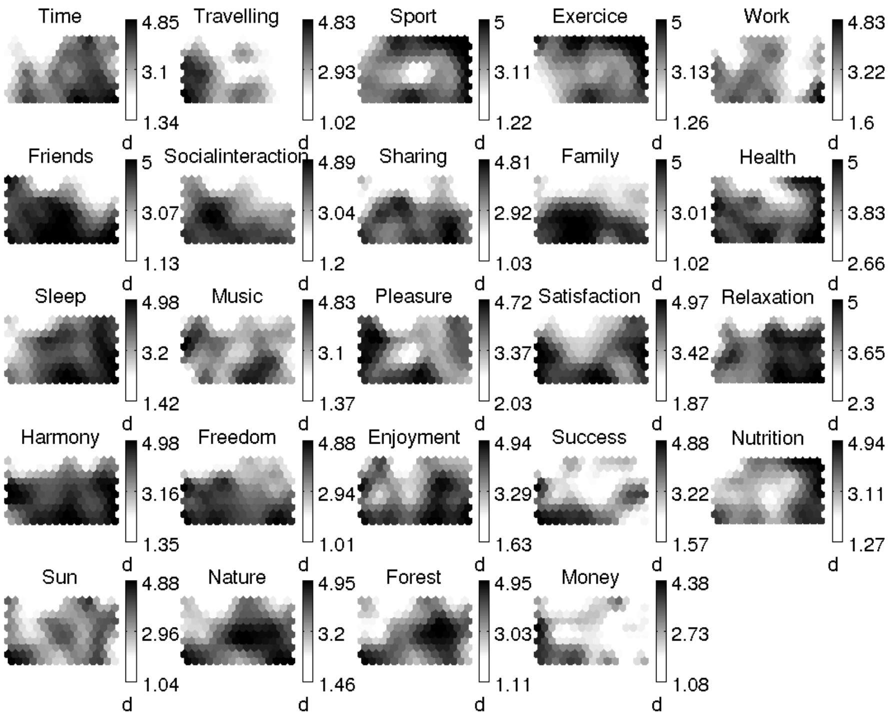


Figure 15: Distributions of context items on the map shown in Figure 14. In these diagrams, a dark color corresponds to a high value (close to 5) and a light color to a low value (close to 1).

corner. The rest of the subjects are scattered around the map without any obvious pattern.

In addition to considering the value of the context assessment of each subject-focus item pair shown in Fig. 14, one can also analyze the relationships between the distributions of each context item. The distributions are shown in Fig. 15. For instance, the distribution of the Exercise context on the map coincides very well with the focus items on Fitness in Fig. 14. The distribution of Exercise seems to be quite opposite to that of Travelling, Social interaction or Friends. This seems to indicate that the participants have viewed exercise to be separate from the social aspect of life. It is not a surprise that the distributions on please and satisfaction coincide almost fully.

The relationships between the focus items can be made explicit by creating a map shown in Fig. 16. As an example of a clear result, one can pay attention to some specific pairs of context items. Each item in the pairs “money-success”, “sharing-social interaction”, “sport-exercise” and “sleep-relaxation” can be found near one another on the map. They can therefore be considered as closely related context items among the participants of this survey.

As we are not showing the identity of the persons who participated the analysis, an informed interpretation of the map shown in Fig. 17 is not possible here. Remembering that the dark colors on the map denote large distances in the original data space, it can be concluded, for instance, that subjects 6 and 9 are very similar to each other but at the same time considerably different from all the others.

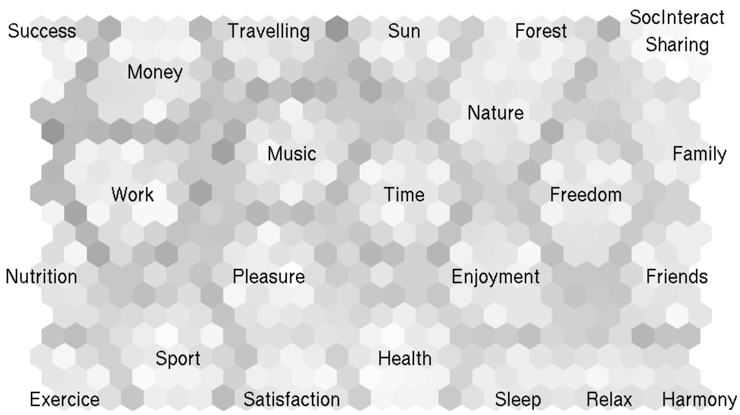


Figure 16: Map of context items.

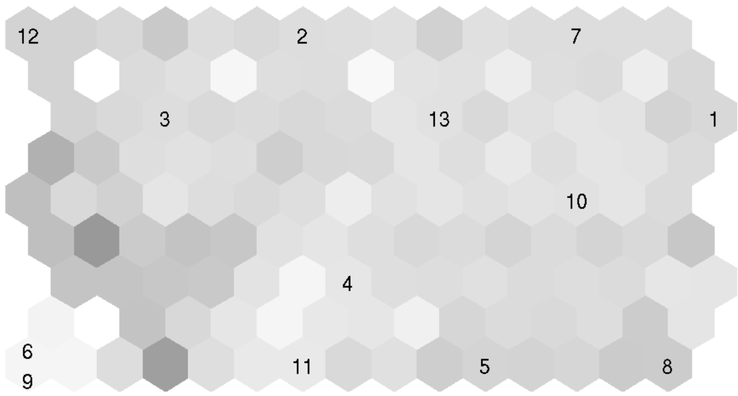


Figure 17: Map of people.

3.4 Knowledge to action

The results of the analysis can be utilized in working with the participants. For example, the map of people can be examined to see whether clear groups of different conceptualizations arise. The found differences among the groups can then be looked into more closely (i.e. which concepts differ, and in which of the context terms, as was done with the Relaxation concept). Interactive presentation of such results to the participants and subsequent discussion is likely to clarify the different conceptualizations among the group.

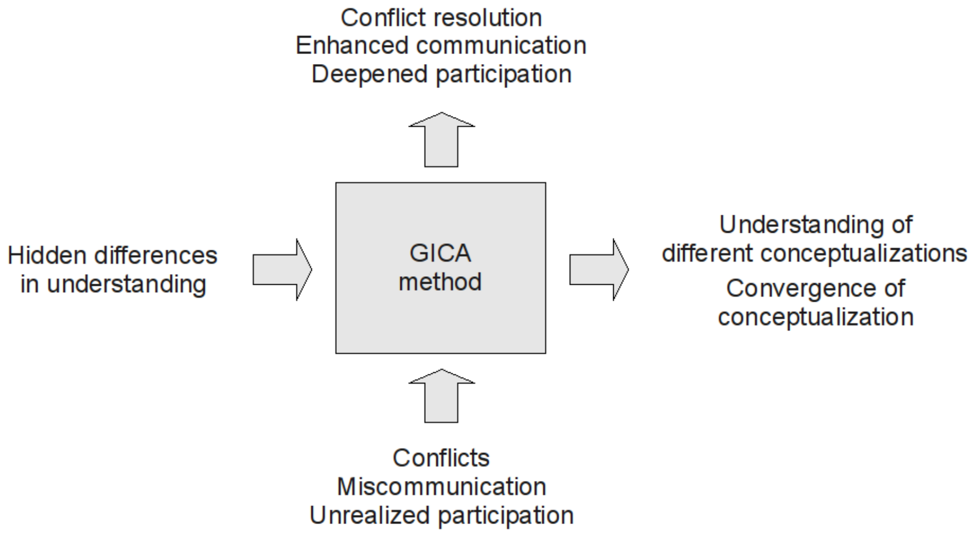


Figure 18: Potential epistemological and social outcomes of the use of the GICA method.

One potentially useful practice is to use the GICA method to detect and highlight potential of and cases of false disagreement (as well as false agreement, see Section 1.4). As an overall result, we expect to see heightened mutual respect and increased ease of communication among the participants. Fig. 18 summarizes the potential benefits and areas of use for the method.

4 DISCUSSION

In the following, we discuss potential application contexts for the GICA method. In our view, the new method is highly useful in, at least, the contexts of 1) participatory decision making processes (e.g. Rowe and Frewer 2000; McNie 2000) and 2) participatory or user-centered design (e.g. Schuler and Namioka 1993; Asaro 2000). Here, we will consider only the first of these application contexts in more detail. We begin by providing a brief review of participatory methods at a general level. Next, we discuss the so-called Q method, which has been claimed to provide access to differences in individual subjectivities, and relate this method to a general discussion on barriers for successful communication in participatory processes. Finally, we consider the usefulness of our method in the selected application context.

4.1 Participatory methods

Research across various disciplines and topic areas has identified a number of methods of involving people in decision making. For instance, Rowe and Frewer (2005) list over a hundred different public engagement methods, some examples of which are community-based initiatives, community research, deliberative polling, citizen juries, stakeholder dialogues, scenario workshops, consultative panels, participatory planning processes, participatory development, consensus conferences, stakeholder collaboration, and integrated resource management (McNie 2007).

Rowe and Frewer (2000) have developed a framework for evaluating different public participatory methods specifying a number of evaluation criteria essential for effective public participation. These fall into two types: acceptance criteria, which concern features of a method that makes it acceptable to a wider public, and process criteria, which concern features of the process that are liable to ensure that it takes place in an effective manner (Rowe and Frewer 2005: 3). Examples of the former are representativeness of participants, independence of true participants, early involvement, influence on final policy, and transparency of the process to the public. Examples of the latter are resource accessibility, task definition, structured decision making, and cost-effectiveness (Rowe and Frewer 2005: 19-20). In their later typology of public engagement mechanisms, Rowe and Frewer identify key variables that may theoretically affect effectiveness – participant selection method, facilitation of information elicitation, response mode, information input, medium of information transfer, and facilitation of aggregation – and based on these variables categorize public engagement mechanisms into communicative, consultative, and participatory (Rowe and Frewer 2005: 251, 265).

The methods listed by Rowe and Frewer that come closest to the method presented in this paper fall under the participatory type. Mechanisms listed under this type are action planning, citizen's jury, consensus conference, deliberative opinion poll, negotiated rulemaking, planning cell, task force, and town meeting with voting (Rowe and Frewer 2005: 277). Rowe and Frewer furthermore divide these mechanisms into four sub-types. Participation type 1 encompasses action planning workshops, citizens' juries, and consensus conferences, and is characterized by the controlled selection of participants, facilitated group discussions, unconstrained participant responses, and flexible input from "sponsors" often in the form of experts. The group output is not structured as such. Participation type 2 includes negotiated rulemaking and task forces. This sub-type is similar to type 1 but with the difference that there is no facilitation of the information elicitation process. Often small groups are used, with ready access to all relevant information, to solve specific problems. Participation type 3 contains deliberative opinion polls and planning cells. This class is also similar to type 1 but with the difference that structured aggregation takes place. In the case of deliberative opinion polling, the selected participants are polled twice, before and after deliberation of the selected issue, and in this process, structured aggregation of all participant polls is attained. Planning cells tend to include various decision aids to ensure structured consideration and assessment and hence aggregation of opinions. Finally, participation type 4 encompassing town meeting with voting is different from the other subtypes in that selection of participants is uncontrolled, and there is no facilitation of information elicitation, although aggregation is structured. (Rowe and Frewer 2005: 281-282).

4.2 Focusing on subjective differences: The Q method

Although recognized by most methods of public engagement and every active practitioner, reference to differences in the ways in which participants subjectively experience the world is not explicitly made in the methods listed by Rowe and Frewer. However, this has been the explicit focus of the so called Q methodology developed by the British physicist and psychologist William Stephenson in the beginning of the 20th century (Brown 2001) and increasingly used in social scientific research, including research on participatory methods in environmental decision making (see e.g. Webler, Danielson and Tuler 2010). The name “Q” comes from the form of factor analysis that is used to analyze the data. Normal factor analysis or the “R” method strives to find correlations between variables across a sample of subjects. The Q method, in contrast, looks for correlations between subjects across a sample of variables; it reduces the many individual viewpoints on the subject down to a few “factors”, which represent shared ways of thinking about some issue (Wikipedia article on “Q method”, Brown 2001).

The Q method starts with the often social scientific researcher collecting a “concourse” on some issue, i.e. a summary presentation, in the form of statements, of all things people say about that issue. Commonly a structured sampling method is used in order to ensure that the statement sample includes the full breadth of the concourse. Then, data for Q factor analysis is generated by a series of “Q sorts” performed by one or more subjects. A Q sort is a ranking of variables, typically presented as statements printed on small cards, according to some condition of instruction. In a typical Q study, a sample of participants, a “P set”, would be invited to represent their own views about some issue by sorting the statements from agree (+5) to disagree (-5), with scale scores provided to assist the participant in thinking about the task (Brown 2001). The use of ranking is meant to capture the idea that people think about ideas in relation to other ideas, rather than in isolation (Wikipedia). Unlike objective tests and traits, subjectivity is here understood to be self-referential, i.e. it is “I” who believes that something is the case and who registers that belief by placing a statement e.g. towards the +3 pole of the Q-sort scoring continuum (Brown 2001). The factor analysis of correlation matrices leads to what Stephenson called “factors of operant subjectivity”, so called because the emergence of those factors is in no way dependent on effects built into the measuring device. The Q methodology is thus based on the axiom of subjectivity and its centrality in human affairs, and it is the purpose of the Q technique to enable persons to represent their vantage points for purposes of holding it constant for inspection and comparison. (Brown 2001)

4.3 Barriers for successful communication in participatory processes

The Q method can be understood as attempting to address one of the many barriers to overcoming difficulties associated with differences in perspective among participants in participatory processes. This is also the view of Donner (2001: 24), who understands this methodology to fill the gap between qualitative tools to capture these perspectives, which can be detailed and contextual but also messy, time-consuming, and difficult to administer consistently, and quantitative tools, which can be clear and methodical, but also oversimplified, rigid, and unwieldy. The Q method, by being a tool that combines the richness of interviews with the standardization of a survey, thus represents an attempt to make such differences "discussible, as an early as an early step in a collaborative effort to help construct action plans that most stakeholders can embrace" (2001: 24). It allows social scientific researchers to explore a complex problem from a subject's – the participant's – point of view, i.e. in accordance with how they see the issue at hand: "Because the results of a Q-sort analysis capture the subjective 'points of view' of participants, and because the data are easy to gather, easy to analyze, and easy to present, Q-methodology is good not only as a research tool but also as a participatory exercise" (Donner 2001).

From the research on the integration of knowledge perspectives (for instance, Thompson Klein 1990; Bruun, Langlais and Janasik 2005; Bruun, Thompson Klein, Huutoniemi & Hukkinen 2005) we know that overcoming difficulties associated with differences in perspective is no easy task. There are numerous barriers to such communication across perspectives. For instance, Bruun et al. 2005 list the following barriers: (1) Structural barriers, which concern the organizational structure of knowledge production; (2) Knowledge barriers, which are constituted by the lack of familiarity that people working within one knowledge domain have with people from other knowledge domains; (3) Cultural barriers, which are formed by differences in cultural characteristics of different fields of work and inquiry, particularly the language used and the style of argumentation; this category also includes differences in values; (4) Epistemological barriers, which are caused by differences in domains of how they see the world and what they find interesting in it; (5) Methodological barriers, which arise when different styles of work and inquiry confront each other; (6) Psychological barriers, which occur as a result of the intellectual and emotional investments that people have made in their own domain and intellectual community; and finally (7) Reception barriers, which emerge a particular knowledge perspective is communicated to an audience that does not understand, or does want to see, the value of communication across and integration of knowledge perspectives (Bruun, Thompson Klein, et al. 2005: 60-61).

4.4 Summarizing our contribution

The barriers that the Q method attempts to address mainly revolve around the cultural, knowledge, and epistemological barriers. The method thus shares many of the assumptions of the GICA method developed in this paper, not least the "axiom of subjectivity". However, the Q methodology does not explicitly address the potentially different ways in which members of P sets understand the concepts used in the concourse or statement pool differently. It might be that when reading the statements in the concourse, different participants take the concepts used in them to mean very different things. Therefore, although sophisticated from the point of view of capturing the potentially different ways in which the participants experience their world, the Q method might still mask conceptual differences in underlying world views. We therefore propose an additional barrier to successful communication across different perspectives, that of *conceptual barriers*, which occur as a result of the different ways in which stakeholders conceptualize and make sense of their worlds (Honkela et al. 2008).

Furthermore, based on our brief review of participatory methods and barriers to collaborative action and of the until now closest approximation of subjective differences, the Q method, we suggest that the GICA method as we have developed it here provides a unique and relatively easily administered way of approaching the subtle yet potentially significant conceptual differences of participants in various kinds of participatory processes. As such, it partakes in a general endeavor of decreasing language-related misunderstandings and resulting collapses of meaning and action.

4.5 Future directions

This report is the first full presentation of the GICA method in its explicit form. We plan to apply the method in different real world cases to gain additional understanding on the applicability of the method and to facilitate its further development. We also consider providing access to computational tools that would help the community to use the method.

In addition to the approach presented in this report, there are other alternatives for obtaining data for a focus item-context-subject matrix. The subjects may be asked to provide associations to the focus items. This gives rise to a sparse data that also resembles labeling data gathered through crowdsourcing. Furthermore, one can create the matrix by analyzing text corpora written by different authors. In order to conduct the analysis in a meaningful and successful manner, a sophisticated preprocessing phase is needed. Perhaps the most advanced but at the same time most challenging approach would be to apply brain imaging techniques (see e.g. Pulvermüller 2001).

We are aware of the fact that often conceptualizations are tightly connected with values (see Janasik, Salmi & Castán Broto 2010). We plan to extend the GICA method to address this issue explicitly by allowing the statements related to each topic and the underlying concepts to be analyzed in parallel.

In summary, we wish that the GICA method will be a useful tool for increasing mutual understanding wherever it is needed.

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